suffering. This warning of rain did much to allay the existing anxiety, and caused many stockmen to delay undertaking expensive methods to prevent loss. About one-half inch of rain occurred in the Sacramento Valley and central coast section. This was followed by another rain in northern California from the 19th to 21st.

On December 28 warnings of a severe norther were distributed throughout northern California and northwest storm signals ordered at points from San Francisco northward, and a warning of much colder weather, accompanied by snow, was distributed in Nevada and Utah. A maximum wind velocity of 32 miles an hour occurred at Eureka and 72 miles northwest at Point Reyes, and high north to northwest winds and gales prevailed throughout the State north of the Tehachapi during the night of the 28th and the 29th. Maximum velocities of wind of 36 miles per hour were reported from Carson City and Winnemucca and 60 miles at Independence. A current velocity of 20 miles from the northwest was reported from Salt Lake City. The gales in Nevada and Utah were accompaned by snow, the temperature falling to 4° and 6° above zero on the morning of the 30th in Nevada and Utah.

On the last day of the month the conditions indicated that a storm of unusual severity was approaching the Oregon coast; southeast storm signals were ordered at points along the California coast north of San Francisco. This storm verified the signals which it is believed were of considerable value.—*W. H. Hammon, Professor, Weather Bureau.*

FROST WARNINGS FOR TEXAS.

The morning map of December 3 showed conditions which might give injurious weather in the sugar and trucking region. A cold wave and "norther" was forecast for Texas by the Central Office at Washington, and the following warning was issued by the Galveston office of the Weather Bureau:

Probably freezing in sugar and trucking region Sunday (4th).

At 2:25 p. m. the following additional warning was distributed:

Temperature will fall to 34° and probably freezing at Galveston, and to 28° 50 to 100 miles from Galveston Sunday morning.

All sugar planters and truck growers to the coast line were advised by telegraph and long-distance telephone to protect their crops, and action was taken accordingly. The sugar cane in the north half of the sugar belt had been cut on advice given November 21. This left standing in the southern portion of the sugar belt about 40,000 tons of cane which it was desired to windrow in case of a freeze. This at the selling price in the field, $3 a ton, made the value $120,000. Besides this there were vegetables subject to loss by freeze which in the aggregate were worth more than $150,000. Sunday morning the temperature fell to 35° at Galveston, 34° at Houston, and to 30° at Brenham. The reports of Sunday morning indicated a further fall in temperature and additional warnings of frost were issued, and sugar planters were advised to prepare for freezing weather. Sunday night and Monday morning there was heavy frost on Galveston Island, and killing frost and temperature as low as 28° in the sugar and trucking regions, and had not the action advised been taken cane and vegetables to the value of many thousands of dollars would have been lost. Many acknowledgments of the value of the warnings have been made. Referring to these warnings the Galveston Daily News of December 6, 1898, remarks as follows:

A heavy white frost put in its appearance yesterday morning, just as predicted by the United States Weather Bureau. While heavy white frosts occur nearly every winter on the mainland, Galveston has an average of one winter in five without frost or freezing, and even with freezing weather heavy white frosts are uncommon on the island. Everybody looked for and made preparation for this frost, because the weather service had said it would occur. The warnings of injurious weather conditions made for this section have been so accurate of late years, and consequently of so great value to the public, that they have become a great factor with the sugar planters and truck growers who care for their extensive crops, as the Weather Bureau advises them. One feature which demonstrates their marked confidence in the warnings is that they take action to protect their crops as the warnings suggest. The different localities have systems in operation for the distribution of information. Some localities have distribution by telephone, others by mounted messenger service, and in others the planters distribute the information from one to his adjoining neighbor until all are advised.

There are few, if any, sections where the weather service can be of greater value than to this part of the country. The large sugar and truck farming interests use the warnings to such an extent that it saves them hundreds of thousands of dollars annually.

I. M. Cline, Local Forecast Official.

PORTLAND, OREG., FORECAST DISTRICT.

Signals were ordered up on the 10th, 18th, and 31st; they were verified in each instance. Numerous freighters, steamers, and sailing vessels heeded warnings and no casualties are reported.

There was no damage resulting from rain, frosts, or high winds. The river had no material rise.

The railroads made considerable use of the snow forecasts during the early part of the month. Fires were kept up in the rotary snow engines and they were moved to the mountain districts upon information issued from this office.

Two carloads of bananas were moved into Oregon and this city upon information issued, and were received and marketed in good condition.

On December 14 forecasts for snow were issued. Snowfall was general, except in and about Portland, where fair weather prevailed.—*B. S. Pague, Forecast Official.*

AREAS OF HIGH AND LOW PRESSURE.

During the month seven highs and nine lows were sufficiently well defined to be traced on Charts I and II. On these charts the circle is placed at the position of the high or low at 8 a. m. or 8 p. m. of each day, and inside this circle are placed the date, time, and barometer reading at the center. The accompanying table exhibits the principal facts relating to the origin, disappearance, duration, and velocity of these highs and lows, and the following special notes are added.

The month has been characterized by pressures largely above normal in the southwest and west, and these conditions have controlled the development and motion of the highs and lows. Oftentimes the rather permanent high area in the Plateau region has spread southeastward into Texas but without any motion.

Highs.—High No. II was the only one originating on the Pacific coast; III and IV were first seen in the north Plateau region, VII to the north of Montana, I in Kansas, and V and VI to the north of Lake Superior. The general motion was to the eastward or southeastward. Nos. II, III, IV, and VII were merged in a subpermanent high in the Gulf of Mexico or over Florida, and I, V, and VI were last noted in the Gulf of St. Lawrence. The temperature oscillations accompanying these highs were very moderate up to the last week of the month. On the morning of the 27th, as No. VII approached Minnesota, Winnipeg experienced a fall of 50° in twenty-four hours and to —18°, and Moorhead a fall of 38° and to 4°. On the evening of the 28th, as the same high approached the Atlantic coast, Northfield reported a fall of 41° and to 8°, and the next morning Eastport reported a fall of

38° and to 8°. The severest cold wave of the month occurred in front of No. I high in the January MONTHLY WEATHER REVIEW. A fall of 52° was reported at Rapid City evening of 29th, and minimum temperatures of —24° and —22° occurred at Duluth and Moorhead, respectively, a. m. of 31st.

Lows.—Six of the lows made their first appearance to the north of Montana; No. V was first noted off the south Pacific coast, No. VII in the south Rocky Mountain region, and No. II in the west Gulf. The general tendency of all the storms was eastward or north of east, and all but V and VII could be followed to Newfoundland. No. VII merged with VI over Lake Huron, and V was last noted off Cape Cod. The highest winds of the month were reported as follows: Evening of 4th, as storm No. II approached the middle Atlantic coast, Cape May reported an east wind of 67 miles an hour and New York City an east wind of 60 miles. On morning of 5th New York City reported an east wind of 76 miles and Block Island a southwest wind of 69 miles. On evening of 5th Eastport reported an east wind of 72 miles. On a. m. of 11th Buffalo reported a west wind of 60 miles while storm No. III was hovering near the Gulf of St. Lawrence.—*Prof. H. A. Hazen.*

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	*30, p. m.	39	96	4, a. m.	49	64	2,370	3.5	677	28.2
II	1, p. m.	39	125	6, p. m.	29	83	3,270	5.0	654	27.2
III	5, a. m.	47	120	11, p. m.	30	90	2,880	6.5	443	18.5
IV	11, p. m.	45	112	18, p. m.	31	80	3,660	7.0	523	21.8
V	18, a. m.	50	86	21, a. m.	48	63	1,380	3.0	460	19.2
VI	24, a. m.	51	90	26, p. m.	46	59	1,530	2.5	612	25.5
VII	26, p. m.	54	107	29, p. m.	32	79	2,250	3.0	750	31.2
Total							17,340	30.5	4,119	171.6
Mean of 7 paths							2,477		588	24 5
Mean of 47.5 days									569	23.7
Low areas.										
I	*29, a. m.	49	124	2, p. m.	38	97	1,740	3.5	497	20.7
II	1, a. m.	27	94	6, p. m.	48	53	3,240	5.5	589	24.5
III	4, a. m.	52	114	8, p. m.	47	52	2,850	4.5	633	26.4
IV	16, a. m.	54	117	19, a. m.	49	53	2,820	3.0	940	39.2
V	16, a. m.	32	119	20, p. m.	41	69	3,210	4.5	713	29.7
VI	19, a. m.	53	118	24, a. m.	49	51	3,240	5.0	648	27.0
VII	20, p. m.	37	107	22, p. m.	46	84	1,590	2.0	795	33.1
VIII	24, p. m.	54	111	29, a. m.	47	54	2,700	4.5	600	25.0
IX	26, p. m.	55	120	31, a. m.	47	52	3,210	4.5	713	29.7
Total							24,600	37.0	6,128	255.3
Mean of 9 paths							2,733		681	28.4
Mean of 47.5 days									665	27.7

*November.

RIVERS AND FLOODS.

The crest of the rise which was moving down the lower Mississippi at the close of November reached New Orleans on the 2d of December with a maximum stage, however, of but 6.2 feet, which was the highest for the month. Above there was a general fall in the Mississippi and Ohio and their tributaries which continued in the Mississippi and Missouri until the 16th, when, owing to a moderate thaw, a rise began in the lower Missouri and middle Mississippi, the advance reaching St. Louis on the same day. A similar cause inaugurated a slow rise in the Ohio, commencing at Pittsburg on the 17th. Heavy rains on the 18th and 19th over the Mississippi and Ohio valleys accentuated matters, and a pronounced rise set in over both rivers. The rise in the Mississippi and Missouri was of limited extent, the crest reaching St. Louis on the 26th when the gauge read 9.8 feet, a rise of 9.3 feet in eleven days. The wave in the Ohio continued to increase at Pittsburg until the crest of 15.2 feet was reached on the 22d, a rise of 13 feet in five days, 7 feet of which occurred during the twenty-four hours ending at 8 a. m. of the 21st. The crest continued down the river, reaching Wheeling on the 23d, Parkersburg on the 24th, Cincinnati on the 27th, with a total rise at the latter place of 21.6 feet in nine days to 31.9 feet, Louisville on the 28th, Evansville on the 30th, and Cairo on January 1, 1899, the increase from the Mississippi also reaching there on the 27th and 28th. In the lower Mississippi the rise began at Memphis on the 22d, Vicksburg on the 26th, New Orleans on the 28th, and continued at the end of the month. The rises in the tributaries occurred as a rule between the 19th and 25th.

No flood stages occurred, and a slow fall was in progress at the close of the month north and east of Cairo, except at Pittsburg. The tributaries were also falling generally, except those of the extreme upper Ohio.

In the Atlantic and Southern States and on the Pacific coast matters regarding river stages were uneventful and nothing of importance was recorded.

With the progress of the winter season there was a rapid advance of the ice line to lower latitudes. During November the southernmost limit reached by floating ice was about the mouth of the Missouri River, and the lowest limits of total freezing were Omaha on the Missouri and Leclaire, Iowa, on the Mississippi. Conditions on the upper Missouri remained practically unchanged during the month, but south of Omaha there was a considerable increase in the amount of ice, although there were no gorges of consequence. The river closed for a short time on the 9th about 2 miles above Kansas City, and ice 9 or 10 inches thick was harvested on the same day. At Boonville, Mo., there was floating ice constantly after the 5th, and on the 15th there was a gorge extending from a short distance below Boonville to Hermann, Mo., the ice remaining solid at the latter place uutil the 18th. Navigation was suspended on the 8th, and had not been resumed at the close of the month, heavy floating ice still continuing. From Omaha northward there remained solid ice, varying from 10 inches in thickness at that city to 20 inches at Bismarck, and there were also 24 inches at Moorhead on the Red River.

On the Mississippi the ice became solid at Davenport on the 7th and at Keokuk on the night of the 8th, while the Des Moines River at Des Moines froze over on the 9th.

Floating ice was generally present north of the mouth of the Missouri River, and at Hannibal there was a gorge above the Wabash bridge which lasted from the 4th until the evening of the 28th. At St. Louis there was floating ice on the 5th and 12th, at Chester on the 6th and 13th, and a small quantity at Cairo on the 8th and 9th. At the close of the month the ice ranged in thickness from 14 inches at Keokuk to 22 inches at St. Paul.

The Illinois River at Beardstown, Ill., closed on the 8th.

The Ohio was full of slush ice at Pittsburg on the 7th and also on the 10th and 11th. On the 15th navigation was necessarily closed. On the 20th the thaw resulted in a quantity of slush ice in the Allegheny, which lasted until the 31st. At Parkersburg there was heavy ice in both rivers from the 10th to the 12th, and the Ohio was frozen over from the 13th to the 18th. Navigation was resumed on the 19th and continued, although the river was not free from ice until the 25th. At Portsmouth, Ohio, navigation was suspended from the 11th to the 20th on account of running ice. At Cincinnati running ice, beginning on the 9th, caused a temporary suspension of navigation on the 10th. On the 14th the river was full of ice, and navigation was again suspended, but the thaw of the 19th permitted its resumption, and on the 21st the river was practically free from ice. At Louisville navi-